Fabrication of Ionic Polymer Metal Composites by Electroless Plating of Pt

James Jungho Pak*, *Seung-Eun Cha, *Ho-Jung Ahn, **Seung-Ki Lee

*School of Electrical Eng., Korea University, Seoul, 136-701, Korea
**Dept. of Electrical Eng., Dankook University, Seoul, 140-714, Korea

Ionic polymer metal composite (IPMC) generally consists of a perfluorinated polymer electrolyte sandwiched by electroplated platinum (Pt) on both sides. Two of the most popular base polymer fiilms are Nafion® (perfluorosulfonate, made by DuPont) and flemion (perfluorocarboxylate, made by Asahi Glass in Japan). IPMC can be used either for a sensor or for an actuator application because a slab of IPMC bends with the applied magnetic field and it also can generate electric field when it is bent suddenly.[1,2] Some of the most intriguing properties would be its actuating characteristics at a very low applied voltage (1-2 V) and its versatility of being used in various shapes and sizes. One of the disadvantages of the IPMC is that it can be actuated only when the film is in a wet condition.[3] This study reports experimental results on the fabrication process of ionic polymer metal composites (IPMC) by electroless plating of platinum on a perfluorosulfonic acid film.

A perfluorosulfonic acid film, or Nafion®117 film (Dupont Co. Ltd., 0.007 inch thick) was cut into a 4 cm x 4 cm square sample for electroless plating. The electroless plating generally consists of four basic steps: surface treatment (or roughening), adsorption (or ion exchange), reduction (or primary plating), and developing (or secondary plating). In this experiment, the last step (developing) was omitted and the developing step doesn't seem to make much effect on the plating performance.

Fabrication process and deformation characteristics of a solid polymer electrolyte actuator with Pt electrodes were studied. It was demonstrated that a metal composite with ionic polymer can work as an actuator unit and the electroless plating process of metal on polymer film is essential process step for polymer actuator applications. In electrode development, a sequential plating (adsorption / reduction) procedure has been shown to improve the actuator displacement up to 4 cycles of plating (Figure 1 shows SEM micrographs of the IPMC membranes). This improvement is believed to be due to a built-up of fractal-like Pt deposits into the polymer film, which would provide a high electrode / membrane interfacial area. However, the interfacial area of the current experiment didn't show enough improvement with the increase of the plating cycling at the electrode / membrane interface. Therefore, the process conditions including the surface roughening and plating condition should be improved in order to enhance the actuator performance. The versatility in behavior of the actuator and its potential as an in-vivo medical application still seem quite promising.

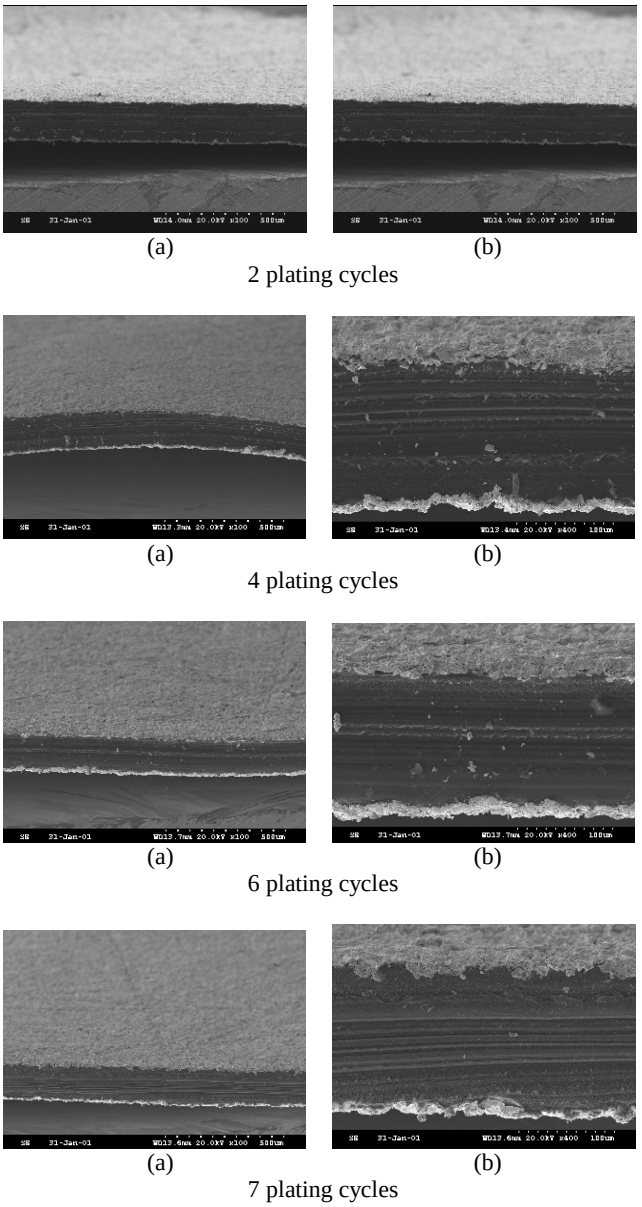

Fig. 1. SEM micrographs (a: ×100, b: ×400) of the plated film built-up depending on the plating cycles.

Acknowledgements

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References

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